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# CITRUS CULTIVATION

—BY—

C. C. GOWDEY, B.Sc, F.E.S., F.Z.S.,
Government Entomologist, Jamaica

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GOVERNMENT PRINTING OFFICE, KINGSTON
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## Historical.

Citrus fruits are first recorded as occurring in the Malay Archipelago and Southern Asia. Though, undoubtedly of tropical origin, it is in the semi-tropics that their development has reached the highest point and where they have been the greatest success commercially.

As compared with such fruits as the olive, date and fig, Citrus are of modern origin. No mention is made of the sweet orange until its introduction into Southern Europe from South China by the Portugese in the fifteenth century. The sour orange originated in India and it was introduced during the tenth century by the Arabs into Sicily and later it was taken to Spain and the New World. The citron, or apple of the Persians, was introduced by the Romans in the third century to Italy. The first reference to the lemon is by the Italians in the twelfth century.

## Classification.

Citrus belong to the family *Rutaceae*. No species of the genus is indigenous to the New World. The only relative occurring in the New World is the prickly ash, *Xanthoxylum americanum*, in the southeastern United States.

The species grown in this island are—

*Citrus sinensis*—sweet orange, including the Washington Navel, Valencia, Mediterranean, etc.

*Washington Navel.*—Fruit rounded, longer than wide, slightly tapering towards apex; skin, smooth to pebbly, from $\frac{1}{8}$ to $\frac{1}{4}$ of an inch in thickness; very juicy, flavour, excellent; colour, orange; seedless, except in a few cases. Tree small, prolific, thornless, except on vigorous shoots. This variety originated in Brazil.

*Valencia* or *"Tardiff,"* or *"Hart's Late."*—Fruit oblong, tapering towards the base; colour, pale orange; skin, usually smooth; thin, juicy, flavour, slightly acid; seeds, three to six, sometimes seedless. Tree large, prolific, thorns few. This variety originated in the Azores.

*Parson Brown*—Fruit oblong; colour, pale orange; skin of a fine texture; juicy, sweet. Tree, medium sized, prolific. This is an early bearing variety and on this account is a great favourite in the colder citrus sections. It is grown successfully on sour stock.

*Mediterranean.*—Fruit rounded; slightly flattened; colour, deep orange; skin, smooth; juicy, very sweet; seeds, few. Tree small, leaves small; thornless. This variety originated on the islands of the Mediterranean.

*Pineapple.*—Fruit, very variable in shape; size, medium to large; juicy, with a distinct pineapple aroma; seeds, numerous; skin, glossy, thin. Tree, vigorous, prolific. This is a popular mid-season variety.

*Citrus aurantium*—Seville or sour orange.
" *nobilis*—King orange.
" " var. *delicosae*—tangerine.
" *decumana*—grapefruit.
" *medica*—citron.
" *limonica*—lemon.
" *aurantifolia*—lime.

## Growth.

The growth of Citrus trees is not at a uniform rate throughout the year. They produce new foliage three times during the year with intervening periods of rest. The greatest growth is during the spring just before the flowers appear. A less vigorous growth is made in the summer and another in October or November.

The intensity of the growth depends on climatic and soil conditions, as on these factors depends the rate of flow of sap. And here it may be pointed out that there are two distinct sap currents—one current passes through the inner bark from the leaves to the roots conveying plant food to nourish the growing root tips, while the other current passes through the wood upwards from the roots to the leaves conveying dissolved mineral food taken from the water in the soil by the roots. It is in this reciprocity that the number and intensity of the seasonal growths depends.

## Structure.

*Foliage.*—The variation in the shape and size of the leaves is one means by which the different species of Citrus may be distinguished. For instance, the petiole (wing) of the leaf of the sweet orange is very narrow, of the grapefruit and sour oranges very broad, especially in the case of the leaves on vigorous shoots and it is altogether absent in the citron. There are other differences in the leaves of the several species, such as, for instance, the character of the margins of leaves; in the case of the lemon and lime the margins are indented, while those of the orange are entire.

The presence in the leaf of numerous glands containing a volatile, aromatic oil is characteristic of all species of Citrus, the odour of which varies with the species.

All of the species of Citrus grown in Jamaica are evergreen. The heaviest fall of leaves takes place after the season of heaviest growth, that is, late in the spring.

*Thorns.*—With the exception of a few varieties, for instance, the Washington Navel, all Citrus trees bear thorns. The sweet orange bears the worse kind of thorns. Thorns are borne in the axils of leaves. They are objectionable not only from the point of view of the discomfort attending the picking of fruit and the pruning of trees having numerous thorns, but thorns damage the fruit if the trees are so situated as to be exposed to high winds.

*Flowers.*—The flowers are complete, that is, they possess both stamens and pistils. Colour, waxy-white, except in the lemon and citron the petals have a purplish tint; large and fragrant; calyx, green, three-to five-lobed; petals, thick; four to eight in number, covered with oil glands; stamens, numerous; stigma, large; pollen, golden-yellow, abundant.

Lemon trees bear both complete flowers and flowers having merely rudimentary pistils, but only the complete flowers result in fruit.

*Fruit.*—The fruit consists of a multitude of multicellular juice-containing vesicles enclosed in a more or less thickened skin or rind. The vesicles are attached to the outer wall of the carpel.

*Juice.*—The juice contains about 0.5% of cane sugar, about 1.5% of other fruit sugars, and from 1.02% of citric acid (Washington Navel orange) to 7.5% (lemon).

*Wood.*—Colour, light, no difference between that of the heartwood and sapwood; strong, hard, of a very fine grain.

*Roots.*—The root system consists of a large main or tap root and fibrous roots. The tap root serves to anchor the tree to the ground and to convey food from the fibrous roots to the tree. The tap root is usually cut off when the young seedlings are being transplanted from the nursery. When such root-pruning is practised on sweet oranges lateral roots are developed, and in the case of sour oranges two or even three lateral roots may be developed.

The fibrous roots are the feeding roots. They are large and very numerous. Unlike the roots of most plants, they do not possess root-hairs. In dry situations and if the soil is deep and well aerated by cultivation, the fibrous roots will penetrate far below the surface layer of soil.

## The Growing of Citrus.

The practice of growing Citrus from seed has been discarded in all countries in which the growing of these fruits is undertaken seriously. Citrus fruits are now budded on stock, which is grown from seed. The kinds of stock which are used on a large scale are in the order of their popularity—the sour or Seville orange, the sweet orange and the pomelo.

Sour orange stock is favoured in Europe. The sweet orange stock is used to some extent in California. The sour stock has the advantage of being less susceptible to gum diseases and is better suitable for heavy soils. Oranges budded on sweet stock come into bearing somewhat earlier than when budded on sour stock. Pomelo stock is being used successfully in the gravelly soils of the valleys in California, but the seedlings are most susceptible to gum diseases.

## The Nursery.

The soil selected for the nursery should be a deep, well drained sandy loam. It should be worked into beds having a fine tilth and levelled. The beds should be well soaked with water a day before the seedlings are planted. The seed-beds should be shaded, preferably by one-inch laths one inch apart running north and south and resting on eight-foot uprights. The seeds may be planted by broadcasting, or they may be planted about one inch deep about one inch apart, or pressed into the soil with a plank and covered to a depth of about half an inch with coarse alluvial soil or sand. The last method is the most satisfactory, as the covering of sand reduces the risk of "damping off" fungi attacking the seedlings and to further reduce the risk of such an attack the minimum amount of water for the requirements of the seedlings should be applied during the first two months and no manure or humus should be used in the preparation of the seed-beds.

In order to reduce the percentage of crooked tap roots caused by the difficulty of the root in piercing the seed-coat, the seeds should be soaked over-night in water before they are planted.

When the seedlings have passed the age, about two months, when they are susceptible to the "damping off" fungi, they become susceptible to gum diseases, which may be controlled by spraying with Bordeaux mixture. The seedlings may also be attacked by scale insects and the Citrus Black Fly, in the event of which they should be sprayed with a contact insecticide, such as whale oil soap, kerosene emulsion, etc.

The seedlings should become large enough to be used as stock in about a year after planting. Before the seedlings are removed from the seed-beds the seed-beds should be thoroughly wetted and the soil loosened by means of a spading fork and then the plants may be pulled by hand. Those seedlings having crooked tap roots should be destroyed. Those seedlings which are to be used for stock should be cut off about eight inches above the collar with a sharp knife or axe.

## The Planting of Stock.

The soil selected for the stock bed should be a deep, rich loam. The stock should be planted in rows eighteen inches apart and four feet apart in the rows. They should be planted with a spade, care being exercised to ensure that they are not planted at too great a depth and that their roots are set straight. The soil around the roots should be pressed firmly. Since the roots of citrus dry quickly if exposed to the air, resulting in a heavy mortality, only a few plants should be handled at a time and they shoul be transferred to the stock-bed protected by moss and covered with sacking.

Stocks grown under optimum conditions should be ready for budding in from one to two years, that is, they should measure about three-eights of an inch in diameter three inches above the collar.

## Budding.

Propagation by budding is the universal method now adopted since the seedling method has gone out of favour.

Buds should be cut from vigorous round wood, free from thorns, taken from one to two year old fruiting branches and should be about one foot long and about the size of a pencil in diameter. All leaves should be removed from the bud-wood. Suitable budding wood is more difficult to obtain in the case of oranges, especially in the navel orange, than in the case of lemons or grape-fruit. To surmount this difficulty in the case of oranges it has been found that pruning a year before the buds are required, orange trees will produce vigorous growth of budding-wood.

Stocks should be budded in October and November and failures re-budded in April or May. The usual method of budding is by making with a sharp budding knife a T-shaped incision for the insertion of the bud in the bark of the stock about one half of an inch long at a point about three inches above the ground, preferably under a small branch. The bud is cut by inserting the blade of the knife one-half inch below the bud and pulling the blade beneath the bud to a point about one-half inch above the bud. The bud is then inserted in the incision in the stock with the bottom of the bud downwards and pushed down until the upper end of the bud is below the cross cut of the incision in the stock. The bud is kept in position by wrapping a strip of waxed cloth or tape around the stock several times. The wrapping should be removed after about ten days and the buds examined. If the buds have set they will show a border of greyish tissue around the edges. The wrapping should be replaced loosely on the set buds and removed finally in about a month's time.

## The Training of the Young Budded Trees.

As soon as the buds have started to grow the trees should be tied to stakes with raffia at points about three inches apart under a leaf in order to ensure the young trees having a perfectly straight trunk.

At the same time that the trees are being trained to stakes any side branches should be pruned off and any sprouts originating below the budded stem should be rubbed off. It will be necessary to repeat the latter operation about every three weeks.

The budded trees should be allowed to grow to about three feet tall and then cut back to about two and a half feet. About three to six branches should be allowed to grow out on all sides of the last foot of the stem.

Budded trees grown in a well cultivated and fertilized nursery should be ready for final planting out in the grove in one to two years. So, a period of from four to six years is necessary from the planting of the seeds in the seed-bud to planting out the budded trees in the grove.

## The Removal of the Budded Trees.

In cases in which the budded trees are to be transported only from the stock-nursery to another part of the same farm, they may be cut back to the trunk and removed with naked roots. This is best done by placing a small length of ten inch pipe over the tree and driving it into the soil so that all the lateral roots are cut and the tap root may then be severed by a spade. The tree is thus removed with the minimum damage to or interference with the root system.

When, however, it is necessary to transport the trees a longer dis-distance, the trees should be "balled," that is, a trench about one foot wide and fifteen inches deep should be dug between the rows of budded trees, the tap root cut and the tree removed with a ball of soil around the roots, which should be wrapped in sacking.

## Selection of the Site for the Grove.

*Soil.*—Citrus can be grown profitably on a wide range of soils—from a fine sandy soil to a heavy red loam. The ideal soil, however, is a deep, rich, well drained, sandy loam.

The mistake must not be made of judging a soil by what can be seen on the surface, for it may be found on digging to a depth of a few inches that there is a "hard pan" through which the roots would be unable to penetrate, or, on the other hand, that the subsoil is so coarse that it is unable to retain water and is lacking in plant food.

'Acid' soils should be avoided. Such a condition occurs in swampy land or in soils containing a high percentage of humus. This condition can be removed by the application of lime.

*Situation.*—Citrus trees grown in exposed situations are unfavourably affected by strong winds; the young foliage and flowers may be blown off, the fruit may be scarred by coming into contact with each other or with thorns, and the shape of the trees may be unsymmetrical. So, exposed situations should be avoided or if the soil is so suitable as to tempt one to establish a grove, wind breaks should be established by planting rows of quickly growing trees. The silk oak (*Grevillea robusta*) or Eucalyptus makes good windbreaks. But, they should not be allowed to grow too tall or too thick. An objection to trees as windbreaks is that they tap the food supply of the adjacent fruit trees, but this objection may be overcome by trenching between the rows of windbreak trees and the fruit trees, thus severing the lateral roots of the former.

*Sunlight.*—A generous amount of sunlight is necessary for the growth of the trees, as it is essential for the process of nitrification which takes place in the soil, but in dry situations an excess of sunlight may cause 'scalding' of the fruit and foliage.

*Atmospheric Conditions.*—Generally, scale insects and epiphytes prosper under humid conditions, the fruit are slower in ripening, but the trees bear more prolificly and the crop tends to be more or less continuous than under the reverse conditions. Low humidity causes the fruit to be a deep, rich colour.

## The Planning of the Grove.

When planning a grove three considerations should be borne in mind—symmetry of the grove, economy of space and the convenience of operations in connection with the management of the grove.

There are three systems of lining out a grove which fulfil the three conditions stated above in different degrees—the square, triangular and hexagonal systems.

In the square system of planting the trees are planted at right angles at distances varying from 18′x18′ to 35′x35′. This system permits of cultivation by machinery in two directions.

In the triangular system the trees are planted in rows, but in every alternate row the first tree is planted equidistant between the first and second trees of the preceding row. This system permits of cultivation by machinery in three directions, but reduces the number of trees per acre.

In the hexagonal system six trees are planted equi distant from each other in the form of a hexagon and a seventh in the centre of the hexagon. This system permits of the greatest number of trees per acre.

The usual distances for planting the several species of Citrus are—tangerine, 20′x20′; navel orange, 22′x22′; other oranges, lemon and grapefruit, 24′x24′.

## Number of Trees per Acre for Different Systems.

| Species. | Square. | Triangular. | Hexagonal. |
|---|---|---|---|
| Tangerine .. | 108 | 98 | 126 |
| Navel Orange | 90 | .. | 103 |
| Other Oranges .. | .. | .. | .. |
| Grapefruit .. | 76 | .. | 86 |
| Lemon .. | .. | .. | .. |

## The Planting of The Trees.

The holes in which the trees are planted should be about two feet wide and about one and a half feet deep. If the sub-soil is stony or has a hard pan, it should be thoroughly loosened. To ensure that the trees will occupy the exact point that the stakes were placed a notched

board should be used for guidance. The method of planting varies somewhat, depending on whether the trees have naked roots or are balled.

When naked root trees are being planted any broken roots should be carefully cut cleanly. Care should be taken to see that the fine soil is evenly distributed between the roots to obviate the chance of the roots dying owing to their not being in contact with the soil. The stems should be cut back and the cut surfaces waxed or tarred.

When balled trees are being planted the balls of soil and sacking around the roots should be allowed to remain, only cutting the string binding the sacking.

In both cases care must be taken to see that the trees are not planted too deep, that is, that the soil does not extend to the point at which they were budded. Deep planting, especially in the plains, has resulted disastrously. In such situations it is advisable to fill in the hole in such a manner that the tree is planted on the summit of a cone and the washing away of the soil in the course of time results in the exposure of a few inches of the larger lateral roots.

Care must also be taken that the trees are firmly set in the ground and that they are thoroughly watered.

## Cultivation.

One of the main objects of cultivation is to produce a fine soil mulch in order to prevent over-evaporation of moisture from the soil. Furthermore, by thorough cultivation soil aeration is increased, resulting in a large supply of plant food being rendered available. Cultivation breaks up the particles of the soil and the smaller the particles the larger the area exposed to the solvent action of the roots; moreover, the finer the soil the more easily is it penetrated by the root system, which becomes more extensive and co-ordinate with the more extensive root system is the increased vigour of the plant and increased resistance to disease. Also, proper cultivation improves the conditions for the development of the bacterial organisms in the soil whereby more food is rendered available.

Where it is not possible to cultivate by machinery—by plough followed by disc harrow—it should be done by light spading fork, care being taken that the roots near the plants are not injured.

Two points should be borne in mind: that cultivation should be deeper on heavy than on light soils, and that it should not be done when the soil is either too wet or too dry.

## Fertilization.

Given that the soil has been properly cultivated and is as a consequence capable of absorbing and retaining moisture and is well aerated, our soils are usually rich enough to make it unnecessary to fertilize the grove until it is a few years old.

Citrus draw from the soil nitrogen, phosphoric acid and potash constituents. In California the system of fertilization is to apply per acre 6 to 8 lbs of bone meal in October by drills, 2 lbs. of sodium nitrate in March by handspreading, 12 to 15 lbs. of tankage in April by drills, and 5 to 10 cubic feet of stable manure in August. The Californian furrow-method of applying stable manure to old trees could be adopted here with advantage. This method consists in digging furrows, six to ten inches deep, near the drip of the branches, putting the manure in the furrows and covering the furrows with soil.

## Mulching.

Mulching with any sort of vegetable matter, but preferably with leguminous, is highly desirable in heavy soils and especially in the tropics, for the decay of the material used for mulching adds humus to the soil and in hot countries humus is quickly burned out of the soil.

Humus in the soil increases the water absorbing and retentive powers of a light soil; it makes a heavy soil more workable, thus increasing the aeration thereof, and it increases the nitrogen content of any soil.

## Cover Crops.

Cover crops in the Citrus grove have many advantages and but few disadvantages. They have the advantages of increasing the fertility of the soil, of improving the physical condition of the soil, of increasing the soil bacteria, of adding atmospheric nitrogen when the cover crop is leguminous, and of preventing erosion of the soil on hillsides. On the other hand, they have the disadvantage of causing root-pruning incident to the cultivation of the cover crop, which is not advisable while the trees are blooming or bearing. In Jamaica cow peas and peanuts are probably the best cover crops.

## Intercrops.

The practice of intercropping, that is, of growing crops between Citrus so as to obtain some revenue while the grove is unproductive, is to be recommended only when the intercrops are such that they do not interfere with the well-being of the main crop. But, the practice of handing over parts of the grove to small settlers to get what they can out of the land in return for the upkeep of the grove is not to be recommended.

Vegetables, such as tomatoes, peas, beans and potatoes, may safely be grown as intercrops.

## Removal of Epiphytes.

Such epiphytes as 'old man's beard,' tree-pines and lichens, which tend to cause the tree to become 'bark-bound,' besides being unsightly, should be removed and the tree maintained in a clean condition.

## Pruning.

On this subject there is a great diversity of opinion amongst growers and this is rather as it should be, for there is as much individuality amongst Citrus trees as there is amongst children.

The chief object of pruning is to develop trees of such size and condition as to make it possible for the trees to produce a large crop of A quality fruit.

The custom has been to prune Citrus trees only in so far as to remove dead branches and water-sprouts. The result of such a system of pruning is a tree of dense, impervious foliage growing close to the ground with the fruit distributed on the outer branches.

Old or decadent trees will usually respond to judicious pruning if the soil conditions have been improved by fertilization and thorough cultivation. In the case of young trees there is usually adequate sunshine and ventilation, which are so essential to the process of nitrification which takes place in the soil, but when the trees become larger the overhanging branches restrict the amount of light and in addition pre-

vent the cultivation of the ground beneath them and this portion of the ground becomes hard and provides a smaller amount of nourishment, so that at the time when the trees being larger require more nourishment, the available nourishment is actually lessened. So, such branches should be removed so as to permit of the access of sunlight to the soil and the cultivation of the ground beneath them. By heavy pruning almost the same amount of nourishment can be made available to the old trees as was available at the earlier stages, other conditions being equal.

All suckers, crossed, devitalized and dead branches should be removed and burned.

Pruning, however, must not be regarded as a substitute for cultivation, but as a supplementary measure to stimulate new growth and for the removal of undesirable growth and devitalized branches.

Pruning should be done in the early spring. All the cut surfaces should be tarred.

## Top-Working.

It may become necessary to change the grove from one variety of Citrus to another and this may be done by top-working by one of two methods:

1. By cutting off the whole top and budding into the trunk or into the stubs of the larger branches.
2. By cutting the top back, leaving the branch stubs and budding into the shoots which grow from these stubs.

In either case 'safety' branches are left, in order to draw the sap and to prevent the buds from being 'drowned out.' Large buds should be used and the hard bark from the old branches and trunk near the incisions should be scraped thin. After the buds have begun to sprout care should be taken that they are not crowded out by sprouts arising from the stock.

## Handling of the Fruit.

Citrus fruits should be handled with great care, for even a slight, abrasion of the skin of the fruit may permit of the ingress of organisms, especially in damp weather, resulting in the decay of the fruit. Abrasions frequently occur during the actual picking of the fruit owing to the carelessness in handling of the clippers, or by the picker's finger nails, or by thorns.

Attention should be paid to seeing that the fruit stems are smoothly cut to obviate the risk of puncturing other fruit, and that the calyx is not removed so as to prevent the ingress of decaying organisms at that point.

The fruit should be placed as soon as they are picked in boxes for transportation to the packing house, but these boxes should not be filled to the brim so as to avoid damaging the upper layer of fruit. On arriving at the packing house the fruit should be washed to remove dirt and sooty mould in water to which has been added permanganate of potash, 1 lb. to 1,000 gallons of water. This also serves to disinfect the fruit, killing any organisms which set up decay and which may be present. Washing may be done by passing the fruit through a machine consisting of revolving brushes on which a stream of water is directed, or by hand. The fruit is then conveyed by a system of belts to the drying racks and thence in the same manner to the graders where the fruit is graded in accordance with shape, colour and condition. The fruit is then graded in accordance with size, being passed through a sizing machine. The fruit is then taken from the sizing machine by the packers

wrapped in soft tissue paper and packed in boxes in accordance with their size. The size is determined by the number of fruit required to fill a box.

## Pests of Citrus.

The Citrus grower will be confronted with the problem of the control of insect pests. It may be even as soon as his nursery has been established, but sooner or later he will have to tackle the problem.

The most important Citrus pests in Jamaica are scale insects and the Citrus Black Fly.

Of scale insects there are no less than sixteen species recorded as attacking Citrus in this Island. Of the most injurious are the Orange Snow Scale, *Chionaspis citri*, which attacks the larger branches; the Purple Scale (known locally as the Musel Scale,), *Lepidosaphes beckii*, which may be found thickly encrusted on the branches, young twigs, leaves and the fruit; and *Selenaspidus articulatus*, which attacks the foliage and the fruit.

The Citrus Black Fly, *Aleurocanthus woglumi*, is unfortunately only too well known to all Citrus growers in Jamaica.

The grubs and adults of the Fiddler beetle have by their girdling of the main roots been responsible for the deaths of a large number of Citrus in certain parts of Manchester. From the facts as stated to me it appears that the trees were being grown in very light soil, so friable that it was possible to push a stick into it to a considerable depth. In localities, therefore, subject to attacks by this insect light soils should not be selected, or, if selected, cultivation should only be carried out to the extent of maintaining the grove free from weeds.

For fuller information with regard to the insect pests of Citrus the reader should refer to pages 29-42 of Entomological Bulletin No. 2 of the Department of Agriculture of Jamaica.—"The Principal Agricultural Pests of Jamaica."

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